

Interactive comment on “Avoiding HFC growth is critical for keeping global warming below 2 during the 21st century” by Y. Xu et al.

Y. Xu et al.

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We would like to thank the Dr Smith for the comments. We have taken into account these suggestions and addressed the raised issues. Please see point by point responses to the comments.

The paper addresses an important topic. Emissions of substances other than CO₂ make a non-trivial contribution to future forcing, and these need to be considered in mitigation strategies.

Long-term projections of HFC emissions are not new, however. Integrated assessment models produce scenarios (including the RCP scenarios) that also contain HFC emissions for reference as well as mitigation scenarios. So it is important that this work

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compare their projections with those from integrated assessment models.

Response: The future HFC emission and forcing up to mid-21st century estimated by several groups are well summarized in Figure 5-5 in the WMO (2011) assessment, which we copied below for reference. There is only one other recent HFC scenario up to 2050 (Gschrey et al. 2011) and its scenario also gives emissions much higher than those from RCPs.

WMO: Report No. 52: Scientific Assessment of Ozone Depletion: 2010, World Meteorological Organization Global Ozone Research and Monitoring Project, Geneva, Switzerland, 2011.

Gschrey, B., Schwarz, W., Elsner, C., Engelhardt, R., (2011) High increase of global F-gas emissions until 2050. Greenhouse Gas Measurement Management 1, 85–92.

There is a bit of an inconsistency here since the authors use RCP scenarios for some data, but then substitute their own HFC projections.

Response: To clarify the scenarios used in this study: CO₂ scenarios for BAU and mitigation case are from RCPs (6.5 and 2.6). SLCPs except HFC are the same as Ramanathan and Xu (2010). HFCs are from Velders et al., 2012. The reason is that the HFC scenarios have not received much attention in the development of the RCPs and RCPs do not follow recent developments. Most, if not all, of the RCP scenarios for HFCs have been developed before 2007 and therefore did not take into account the accelerated HCFC phase-out agreed by the parties to the Montreal Protocol in Sept. 2007. The RCP scenarios also did not take into account the large observed growth in HFC use and concentrations in the atmosphere since 2000.

The IAM models that produced the RCP scenarios have fluorinated gas projections that, in some cases, appear to be more detailed than those produced in this paper

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(.e.g., by gas and sector based on evolution of multiple drivers over time. For example, in the case of GCAM, vehicle demand, building AC use, etc.).

Response: We agree. The IAM models for F-gases have a more detailed description of gases and applications than the scenarios used here, but what is relevant here is the total radiative forcing of the HFCs, not their individual contributions. As mentioned above, the HFC scenarios in the RCPs are not as up-to-date as the more recent ones such as Velders et al. (2009).

All of the modeling groups that produced the RCP scenarios share more detailed data on request. It would be useful to compare the projections in this paper with previous results. The GCAM RCP emissions data, for example, is available from the JGCRI web site. <http://www.globalchange.umd.edu/gcamrctp/>. Note that both reference case and policy case emissions are available here. We have, coincidentally, made available more detailed emission data, including fluorinated gas emissions by gas, available as supplemental material to a recently published paper at: <http://link.springer.com/article/10.1007/s10584-012-0577-3/>. Note that GCAM includes a full suite of fluorinated gas emissions, however these are aggregated into a small number of equivalent emissions (with emissions aggregated based on atmospheric lifetime).

On first glance, the HFC projections used in this paper look to be substantially higher over the long-term than, for example, the GCAM projections. In the most recent GCAM model, for example, HFC forcing is only 0.2 W/m² in 2100, as compared to 0.5 to 0.8 W/m² here. Note that, in the GCAM scenarios, HFC emissions double or triple from 2005 to 2020, so the GCAM simulates the expected large near-term growth as noted by the authors. This difference may be because many of the drivers of these emissions do not scale with GDP over the long-term due to saturation effects. (Building floorspace, for example.) The projections in this paper, therefore, may be substantially overstating the future role of HFCs.

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Note that HFC emissions are much lower in the RCP4.5 scenario as compared to the associated GCAM reference scenario due to explicit mitigation actions. This should also be discussed in the paper. These emission reductions use marginal abatement curves (MAC) developed by EPA and collaborators. These are widely used in the analysis community, so it would be useful if the authors discussed their assumed reduction actions vs what is assumed in the EPA MAC curves. It is not always realistic to assume that all emissions of a specific substance are eliminated. In many cases there are specific uses for which substitutes are not economically attractive (even under significant incentives, such as GHG prices).

Response: Thanks for providing additional details about HFC emissions. Please see the response above related to the status of the HFC in the RCP scenarios. Please refer to Velders et al. (2009) for more details in HFC scenario development.

On another point, as discussed in the RCP scenario papers, it is quite problematic to take emissions from one RCP scenario as a reference case for another RCP scenario. This can lead to inconsistent and misleading results, and needs to be either justified or the data changed to be consistent.

Response: We agree. We now acknowledge this caveat by stating in section 2.2 that “We note that CO₂ scenarios under RCP 6.5 and 2.6 may have different assumptions regard to emission sectors and therefore the difference between those two pathways may not directly represent the effect of mitigation efforts.”

It would also be useful to provide more detail on the HFC projections used in this work (e.g., emissions by substance, region and year).

Response: The HFC scenarios used in this paper have been described in great detail in Velders et al. (2009). References to this paper are in the text.

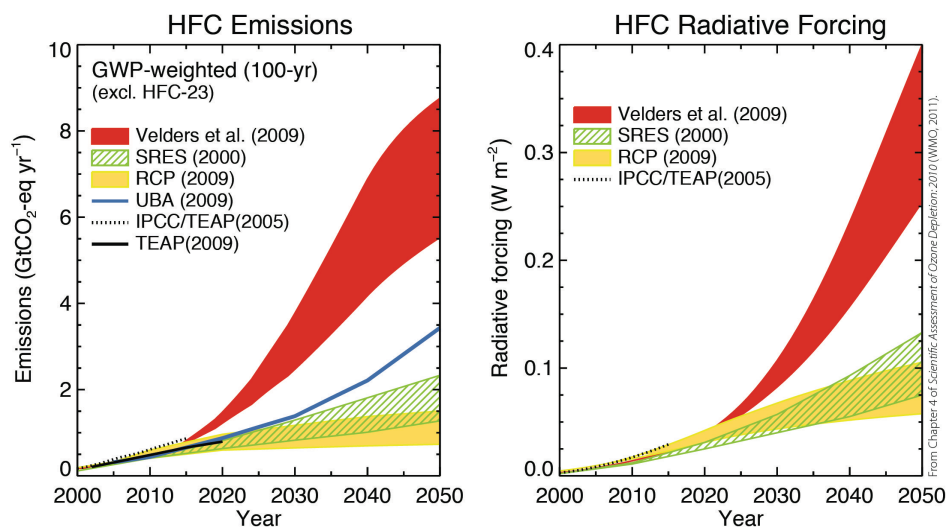


Fig. 1. Figure 5-5 in the WMO (2011) assessment